

Title

Plutonium contamination of vegetation in dusty field environments found in transuranics
in natural environments.

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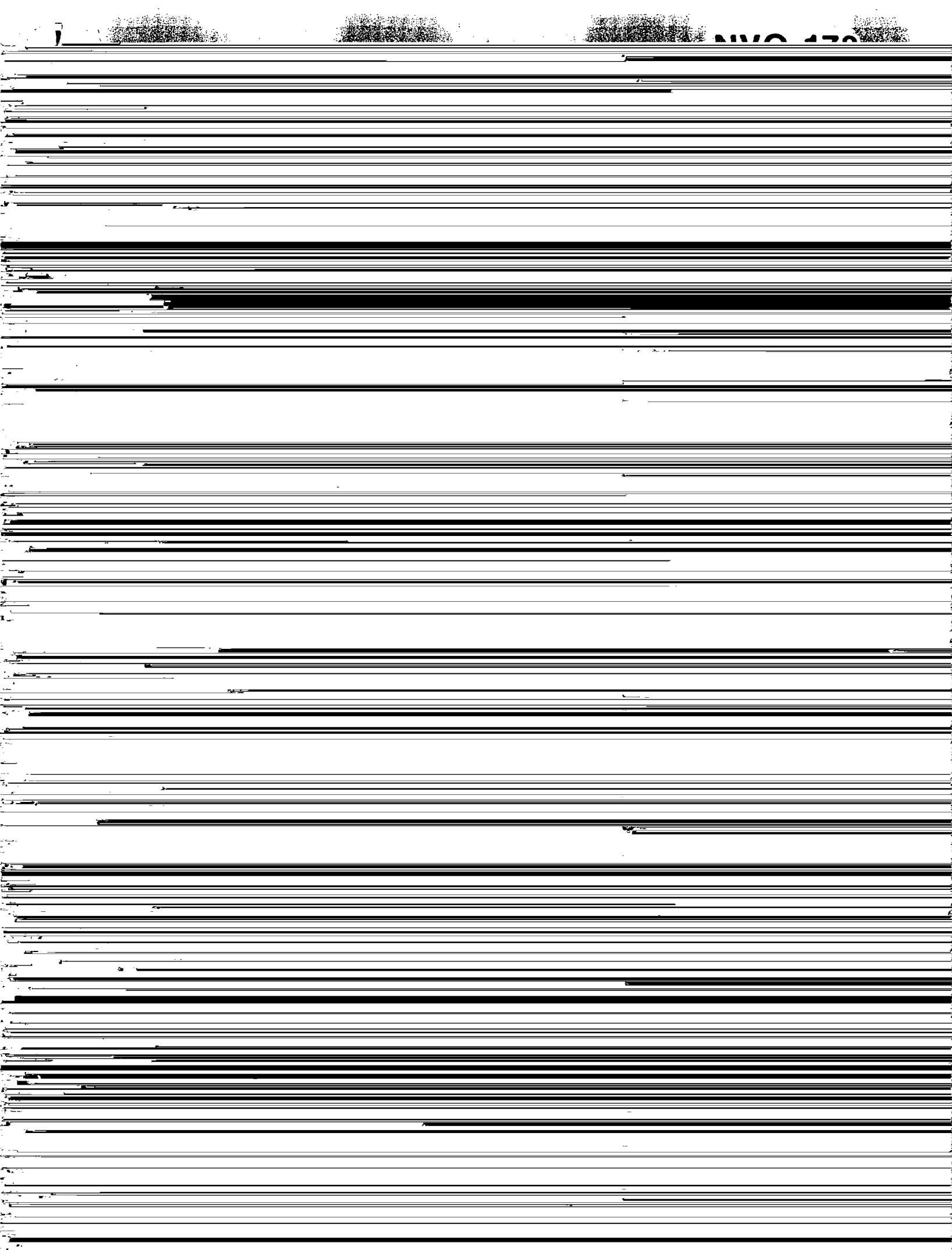
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TRANSURANICS IN NATURAL ENVIRONMENTS



PLUTONIUM CONTAMINATION OF VEGETATION

IN DUSTY FIELD ENVIRONMENTS

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ABSTRACT

Transport of plutonium in food chains of grazing animals and mankind by vegetation carriers becomes an important avenue of contamination in dusty field environments. Findings indicate that most of the activity present in vegetation of such areas at the Nevada Test Site (NTS) is superficial contamination resulting from the attachment of particles to foliage surfaces during resuspension. We suspect, however, that the root uptake pathway eventually will become more significant as the result of natural concentration and recycling processes at work in the field within the plant root zone.

INTRODUCTION

One requirement for this summary is the consideration of the problem

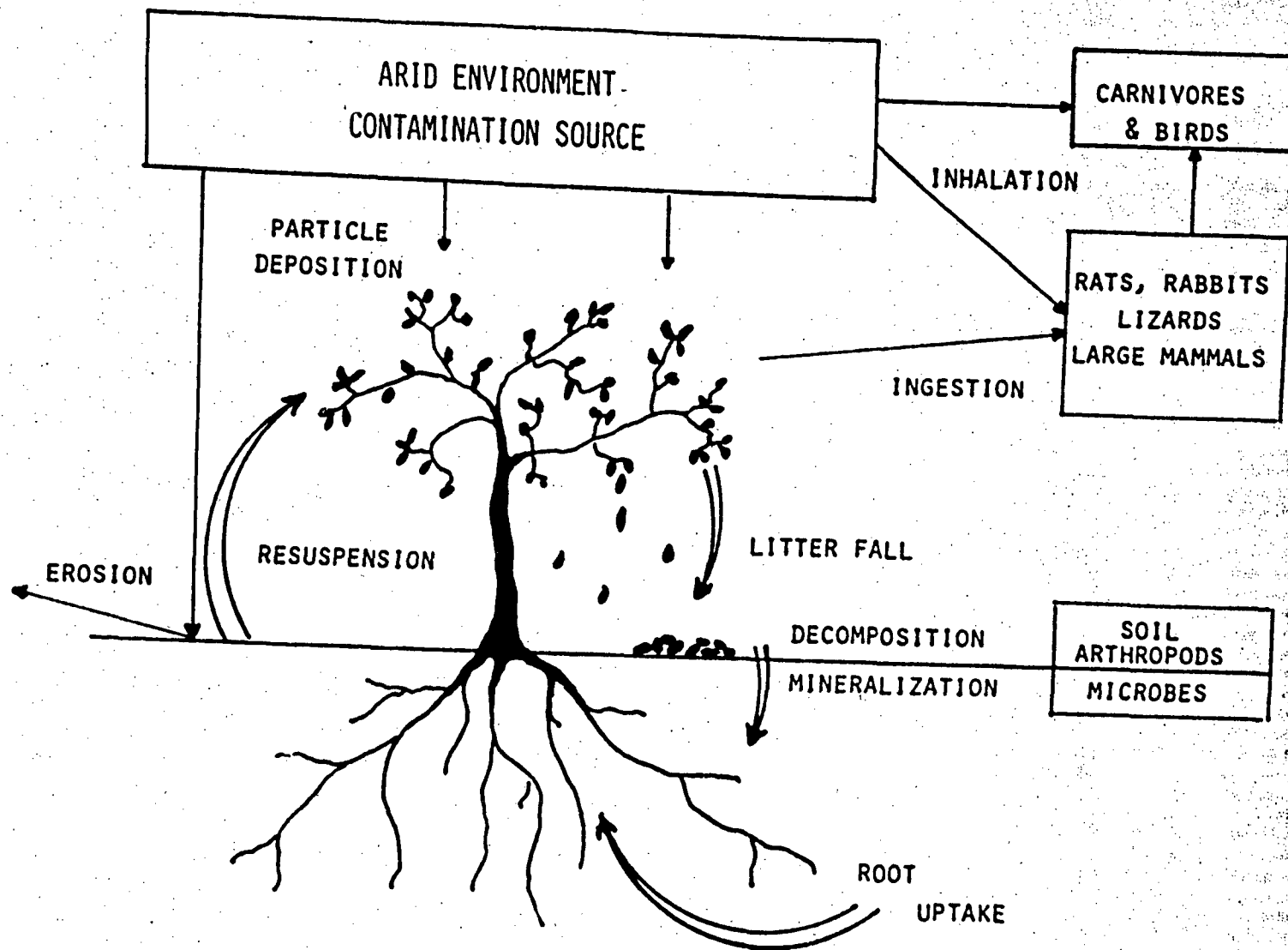


Fig. 1. Simplified illustration of pathways of natural cycling and concentration processes at work in the desert ecosystem.

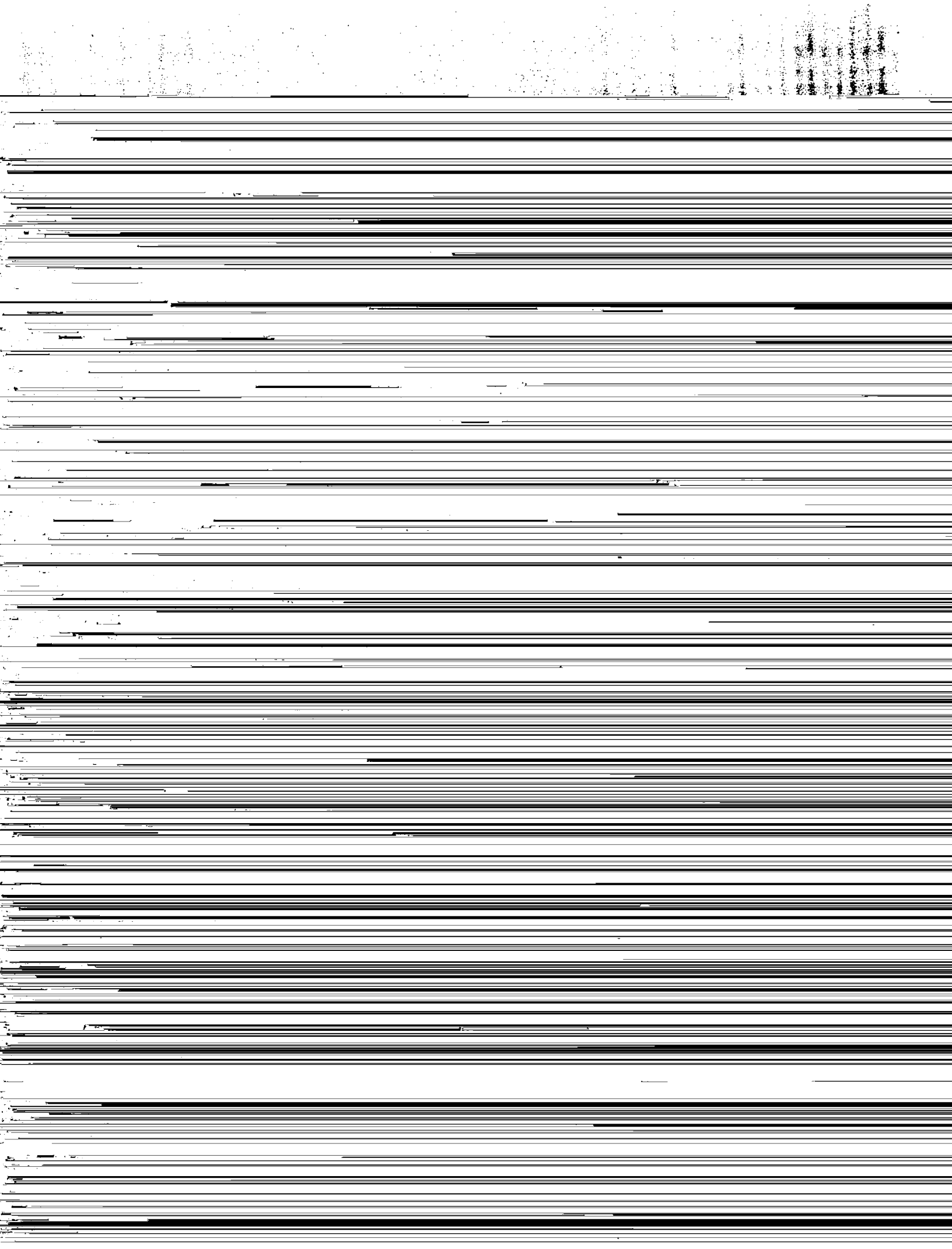


Table 1. Estimated Inventory of $^{239-240}\text{Pu}$ for Vegetation in Activity Strata of Aged Fallout Areas at NTS (Romney et al. 1976). Higher numbered activity strata are nearer ground zero.

Activity strata	n	Mean \pm S.E. (n Ci/g dry)	Mean ^a \pm S.E. ^b (n Ci/m ²)	Inventory \pm S.E. (millicuries)	Percent	Veg. invent. \pm S.E. Soil invent. \pm S.E. ^c
NTS AREA 11, SITE A (1956)						
1	12	.0015 \pm .00057	.76 \pm .35	.095 \pm .045	95	.0029 \pm .0018
2	18	.00064 \pm .000099	.33 \pm .11	.0026 \pm .00082	3	.0050 \pm .0020
3	6	.0010 \pm .00038	.54 \pm .24	.00026 \pm .00011	0.3	.00031 \pm .00033
Total	36			.098 \pm .045	100.3	.0028 \pm .0017
NTS AREA 11, SITE B (1956)						
3	11	.10 \pm .024	60 \pm 40	.58 \pm .14	24	.0020 \pm .00085
2	14	.19 \pm .053	110 \pm 31	.78 \pm .23	33	.00049 \pm .00019
4	19	.57 \pm .087	330 \pm 52	1.0 \pm .16	43	.00023 \pm .000055
Total	44			2.4 \pm .31	100	.00039 \pm .000058
NTS AREA 11, SITE C (1956)						
2	12	.1 \pm .026	61 \pm 12	1.2 \pm .23	27	.0018 \pm .0014
3	14	.26 \pm .054	160 \pm 25	1.0 \pm .16	24	.0018 \pm .00052
4	17	1.1 \pm .61	490 \pm 180	1.9 \pm .72	44	.00035 \pm .00013

Studies of airborne particulates around a contaminated area at the Rocky Flats Plant yielded an average resuspension factor of 10^{-9} m^{-1} during an 8-month sampling period. This factor was near 10^{-6} m^{-1} for particulate material collected upon sticky paper exposed to suspendable fine soil particles from the soil surface. Size distribution studies of all suspended particles containing plutonium indicated a geometric mean diameter of about $10 \mu\text{m}$ (Volchok 1971, 1972). Results from cyclone and elutriator samples indicated median diameters of about $5 \mu\text{m}$. Additional measurements by Selmer and Orgill (1973) and Selmer and Lloyd (1974, 1975) in the Rocky Flat area gave resuspension factors ranging from 10^{-9} to 10^{-5} m^{-1} . The Rocky Flats area is subject to winds which are occasionally very strong and gusty. Environmental surveillance data strongly indicate that the movement of contaminated soil particles by wind was a major force causing the original dispersion of plutonium from a barrel storage area.

associated with the coarse silt (20-53 μm) fraction. Ten percent or less usually is associated with the soil fraction less than 5 μm diameter. Highest activities also are associated with heavy mineral

plutonium for vegetation in these fallout areas. Only small amounts of the total quantity of plutonium originally deposited presently appear to move to the standing vegetation from fenced-in fallout contaminated soils which are now undisturbed, except for natural wind conditions. Advantage can be gained from keeping these sites as little disturbed as possible. This includes surface erosion by water (Hakanson et al. 1976; Hakanson and Nyhan 1976).

RECYCLING OF PLUTONIUM TO VEGETATION

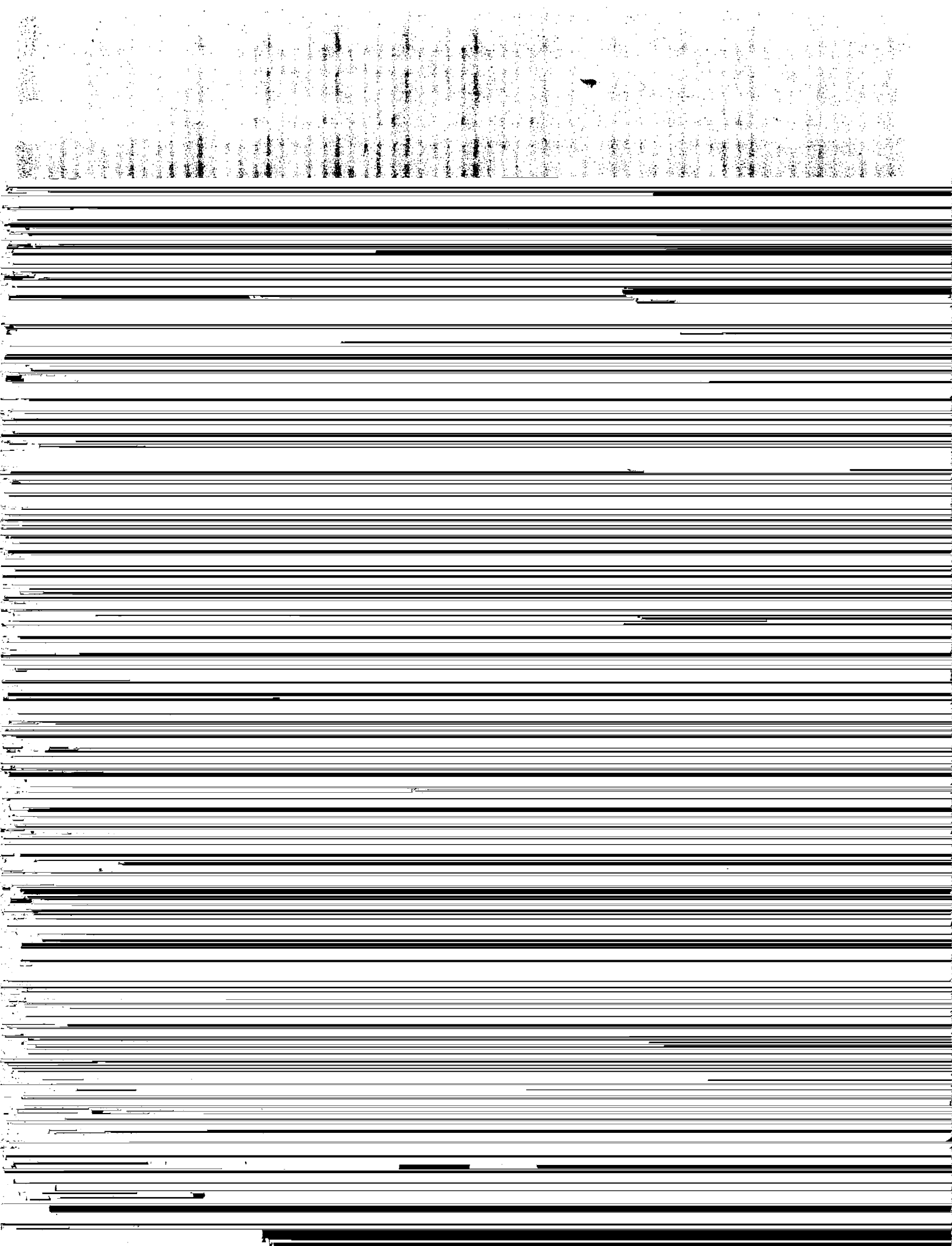
Most of the standing biomass of vegetation in the aged fallout areas at NTS is contributed by deciduous shrubs (2,000 to 6,000 kg/hectare) which normally yield about 10 percent of their total weight as new annual foliage. The production of grasses, forbs and annual plant species is spasmodic from year to year, depending upon rainfall and climatic conditions. Seldom, however, does the productivity of these annual species exceed 1 percent of the standing shrub biomass. As the result, only from 200 to 600 kg/hectare of new plant foliage is potentially available to undergo the processes of litter fall, decomposition and mineralization. Most of the fallen litter is moved about by wind action to lodge underneath sheltering shrub clumps where much of the initial breakdown is carried out by consumer organisms. Very little is known about the impact of soil arthropods and micro-organisms on plutonium in these areas at NTS, but deductions from well known effects of such organisms on inorganic nutrient elements during mineralization processes would indicate that they should help increase the biological availability (solubility) of plutonium with passing time.

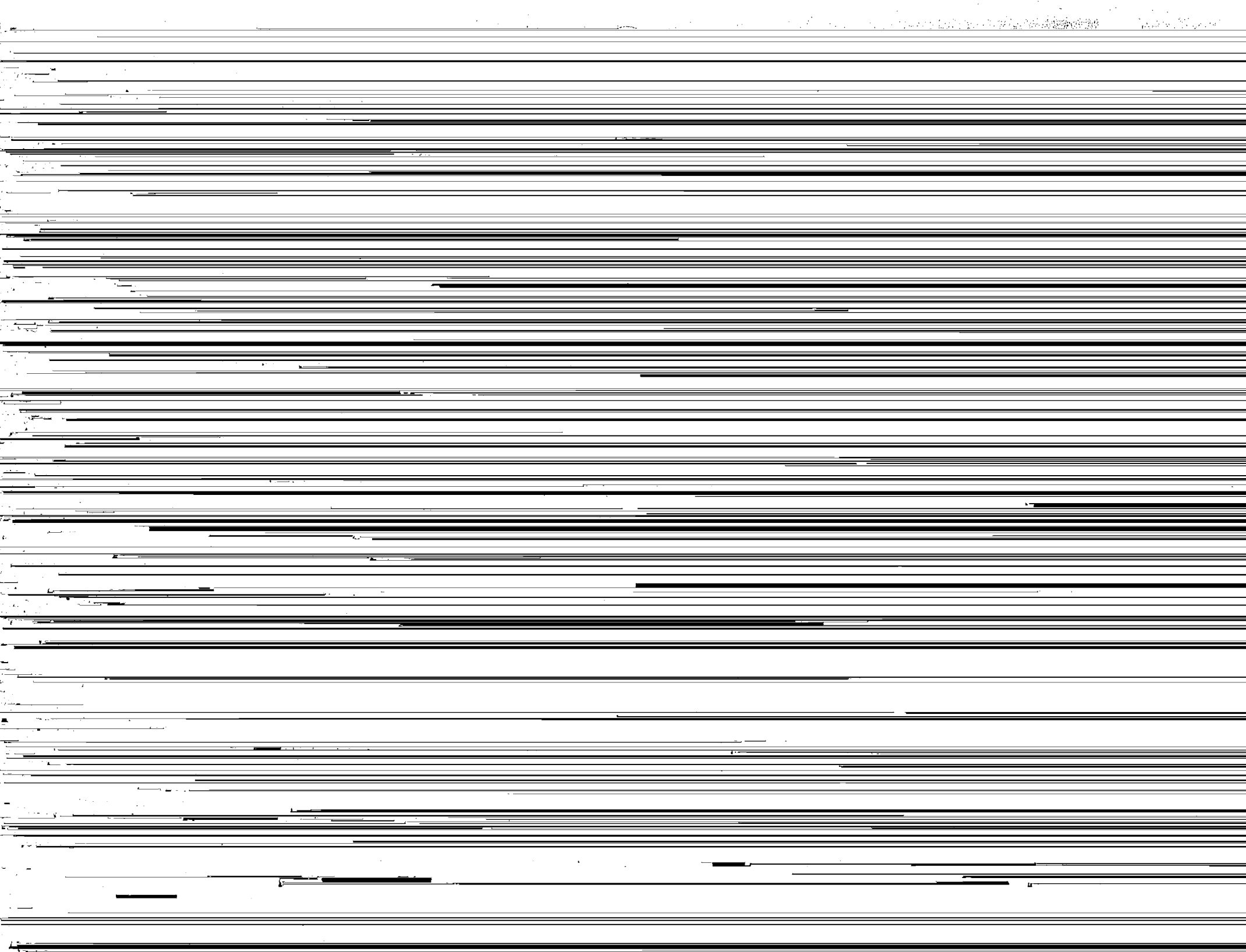
elements in soil is discussed by Wildung et al. (1977, this volume).

First glance at the data in Table 2 gives the impression of an insignificant amount of plutonium in vegetation of the fallout area. However, when one considers that this contaminated plant foliage goes through annual cycles of litter fall and decomposition and mineralization in

RESUSPENSION IN CONTAMINATED AREAS

Once radioactive material has been deposited upon soil, the main concern is to control subsequent resuspension, especially in dry, dusty areas. Whether or not the contaminating radionuclide remains in an original particulate form or undergoes chemical and physical transformations





CONCLUSIONS

Two principal incorporation mechanisms are involved in the vegetation-carrier transport of plutonium in the diet of grazing animals and mankind: (1) superficial entrapment of particulate material with possibilities of foliar absorption of soluble contaminant, and (2) root uptake of the contaminant entering soil. It is important to reduce this transport of plutonium as much as possible. Findings from studies in dusty field environments at NTS indicate that superficial contamination is presently the most important route. However, certain

REFERENCES

1. Anspaugh, L. R., P. L. Phelps, N. C. Kennedy, J. H. Shinn, and J. M. Reichman. 1974. "Experimental Studies on the Resuspension of Plutonium from the Aged Sources at the Nevada Test Site." In: Atmosphere-Surface Exchange of Particulate and Gaseous Pollutants. Report CONF-74092. pp. 727-743.
2. Anspaugh, L. R., P. L. Phelps, N. C. Kennedy, H. G. Booth, R. W. Goluba, J. M. Reichman, and J. S. Koval. 1974a. "Resuspension Element Status Report." In: The Dynamics of Plutonium in Desert Environments. P. B. Dunaway and M. G. White (Eds.). Report NVO-142. pp. 221-297.
3. Anspaugh, L. R., J. H. Shinn, and D. W. Wilson. 1974b. "Evaluation of the Resuspension Pathway Toward Protective Guidelines for Soil Contamination with Radioactivity." In: Population Dose Evaluation and Standards for Man and His Environment. IAEA Vienna. pp. 513-524.
4. Anspaugh, L. R., J. H. Shinn, and P. L. Phelps. 1974c. "Resuspension and Redistribution of Plutonium in Soils." In: Proc. Second Annual Life Sciences Symp., Plutonium--Health Implications for Man. May 22-24, 1974. Los Alamos, New Mexico.
5. Anspaugh, L. R., J. H. Shinn, and P. L. Phelps. 1975. "Resuspension and Distribution of Plutonium in Soils." Report UCRL-76419.
6. Bernhardt, D. W., and G. G. Eadie. 1976. "Parameters for Estimating the Uptake of Transuranic Elements by Terrestrial Plants." USEPA Technical Note. ORP/LV 76-2.
7. Bretthauer, E. W., P. B. Smith, A. J. Cummings, G. B. Morgan, and S. C. Black. 1974. "Preliminary Report of the Chemical and Physical Properties of Airborne Plutonium Particles at the Nevada Test Site." U.S. Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. (Presented at 1974 American Industrial Hygiene Association Meeting).
8. Brown, K. W. 1976. "Americium--Its Behavior in Soil and Plant Systems." USEPA Ecological Research Series. EPA 600/3-76-005.
9. Carfagno, D. G., and W. H. Westendorf. 1973. "Radionuclide Cycling in Terrestrial Environments." Report ORNL-4848.
10. Dahlman, R. C., E. A. Bondietti, and L. D. Eyman. 1976. "Biological Pathways and Chemical Behavior of Plutonium and Other Actinides in the Environment." In: Actinides in the Environment. A. N. Friedman, Ed., ACS Symposium Series 35. pp. 47-80.

